Occurrence and co-occurrence of nonsuicidal self-injury and disordered eating in a daily diary study: Which behavior, when?

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Abstract

Although research has explored between-person traits that may account for the high rates of co-occurrence between non-suicidal self-injury (NSSI) and disordered eating (DE), little is known about within-person processes that predict which behavior occurs and when. This study describes the socioemotional contexts of NSSI and DE behaviors during a naturalistic, two-week daily diary period. Young adults (aged 18-35) who reported ≥ 1 episode of NSSI and ≥ 1 episode of DE (binge eating, purging, or fasting) during the two-week monitoring period were included (*N* = 25). NSSI and DE co-occurred approximately one third of the time. NSSI occurred following a greater number of interpersonal stressors and specific negative emotions, compared to DE. Participants were more likely to act on NSSI thoughts following arguments and feelings of rejection. They were more likely to act on binge eating/purging thoughts after eating or watching television, and when they felt self-hatred. They were more likely to act on fasting thoughts after discussing upsetting memories, and when they were in a public setting. NSSI days were also marked by more intense negative mood in the evenings relative to fasting days, and greater fatigue in the morning relative to binge eating/purging days. This study underscores the utility of using experience sampling methods to develop and test within-person models to advance our understanding of co-occurring behaviors.

Keywords: self-injury; eating disorder; self-harm; comorbidity; experience sampling.

1. Introduction

Nonsuicidal self-injury (NSSI), defined as any deliberate and self-inflicted physical injury that occurs in the absence of an intention to die (International Society for the Study of Self-injury, 2007), and disordered eating (DE), defined as eating and weight control behaviors that are both maladaptive and atypical (Stice et al., 2009), frequently co-occur (Claes and Muehlenkamp, 2014). Among eating disorder patients, 32% to 70% endorse a lifetime history of NSSI (Claes et al., 2001; Favaro and Santonastaso, 1999), and 50 to 61% of people who engage in NSSI report a lifetime history of an eating disorder (Favazza and Conterio, 1989; Nixon et al., 2002). An emerging body of research has examined between-person factors that may explain the co-occurrence of NSSI and DE. Findings have implicated traits such as negative urgency (Claes et al., 2015a; Peterson and Fischer, 2012), emotion regulation difficulties (Muehlenkamp et al., 2012; Ross et al., 2009), problems in identity formation (Claes, et al., 2015b), mood and personality disorder symptoms (Yiu et al., 2014), and negative attitudes toward one's body (Muehlenkamp et al., 2011; Turner et al., 2015) in the co-occurrence of these two behaviors. Moreover, authors have proposed that NSSI and DE behaviors may be "functionally equivalent", meaning they occur in response to similar contingencies and result in similar reinforcing consequences (Claes and Muehlenkamp, 2014). Currently, we know little about the within-person processes that may predict which of these behaviors occurs and under which circumstances. We have yet to discover whether different patterns of environmental (e.g., stressors) or emotional cues (e.g., negative mood) predict whether people are more likely to engage in NSSI versus DE on a given day. Clarifying common and differential processes associated with NSSI and DE within individuals who engage in both types of behavior may help clinicians determine what to focus on to help clients reduce these behaviors.

Micro-longitudinal methods hold promise for answering questions about the contexts in which individuals choose a particular behavior from a repertoire, as repeated observations of the same individual allow for within-person comparisons of the contexts surrounding different behaviors. Previous micro-longitudinal studies of NSSI, binge eating with and without purging, and fasting highlight similar emotional, social and environmental precipitants across these behaviors. For example, studies demonstrate that both intensity (Armey et al., 2011; Berg et al., 2013; Engel et al., 2013; Haedt-Matt and Keel, 2011a; Smyth et al., 2007; Snir et al., 2015) and variability of negative affect (Anestis et al., 2012; Goldschmidt et al., 2014; Lavender et al., 2013; Vansteelandt et al., 2013) predict NSSI and DE. Moreover, studies show that NSSI and DE often occur in response to interpersonal stressors (Goldschmidt et al., 2014; Prinstein et al., 2009), and their associated negative emotions (e.g., feeling rejected or hurt; Nock et al., 2009; Snir et al., 2015), although behaviors themselves typically occur when people are alone (Nock et al., 2009). Micro-longitudinal studies have also investigated the role of food, hunger and weight-related cues in predicting DE (Haedt-Matt and Keel, 2011b; Leahey et al., 2011; Zunker et al., 2011). Thus, micro-longitudinal studies suggest that NSSI and DE may occur in response to similar emotional, interpersonal, and environmental cues. A critical question, therefore, is when and why an individual might prefer one of these behaviors over the other.

1.1 Aims and Hypotheses

The current study extends the existing micro-longitudinal literature by directly comparing the emotional and social contexts of NSSI versus DE as they occur in daily life among those who engage in both behaviors. The current study used a naturalistic daily diary design as a first step in developing a within-person model of co-occurring NSSI and DE. The use of daily monitoring provides a significant advantage over traditional cross-sectional methods that

ask participants to recall and describe contexts of NSSI or DE in an aggregated way; in this study, participants were asked to describe emotional, social, and environmental contexts for each specific episode of NSSI and DE as it occurred over a two-week period. Although more frequent assessment schedules (e.g., with multiple reports per day) have yielded important insights into NSSI and DE, we used a single daily report in the current study for several reasons. First, the assessment schedule was limited to the least burdensome schedule that would still adequately capture variability in NSSI and DE. Previous micro-longitudinal studies have used a two-week monitoring period to observe DE (Goldschmidt et al., 2014; Smyth et al., 2007; Wegner et al., 2002) and NSSI (Nock et al., 2009), and have demonstrated that NSSI and DE typically occur a few times per week. Thus, we expected that the primary behaviors of interest could be accurately recalled in daily reports, rather than requiring more frequent daily assessments. . Second, this study was not designed to examine emotion regulation functions of NSSI or DE, per se, but rather to describe the occurrence and contexts of NSSI and DE. In line with our decision to employ a retrospective daily assessment, we focused the assessment of affective context on stable, diffuse aspects of *mood* that persist over hours (i.e., valence, arousal, and energy; Wilhelm & Schoebi, 2007; see also Matthews et al., 1990), rather than on specific *emotional states*, which fluctuate more rapidly (cf. Frijda, 1993).

This study aimed to: 1) describe the frequency, functions, and contexts of NSSI and DE within a young adult sample recruited for engagement in NSSI, and 2) compare the intensity and variability of three aspects of mood (negative valence, agitation, and fatigue) on days when NSSI, DE or neither behavior occurred. Although there is a shortage of research comparing episodes of NSSI and DE, the extant literature suggested a few hypotheses. Hypothesis 1 was that participants would be more likely to engage in DE when thoughts began during or following

exposure to food- or weight-related cues (Leahey et al., 2011), for example while eating, watching television, or spending time with others, whereas participants would be more likely to act on NSSI thoughts when they were alone (Shingleton et al., 2013). Hypothesis 2 was that participants would predominantly endorse emotion regulation functions across both types of behaviors. Given the scarcity of direct comparisons of the emotional context of NSSI versus DE, we did not have a priori hypotheses regarding specific emotional states or interpersonal stressors that would be differentially associated with DE or NSSI, nor did we have a priori hypotheses regarding differences in the relative contribution of intensity or variability of mood to the prediction of NSSI versus DE.

2. Method

2.1 Participants

Participants from this study were drawn from a larger investigation of the emotional and interpersonal context of NSSI (see Turner et al., 2016). Young adults (N = 60, aged 18 to 35) recruited from community websites and post-secondary campuses were eligible to participate if they endorsed recent and repeated NSSI, as indicated by a) at least ten lifetime NSSI episodes, b) at least one NSSI episode in the past 12 months, and c) thoughts or urges for NSSI within the past two weeks. Exclusion criteria included psychiatric conditions that could interfere with diary compliance, including a current major depressive or manic episode, substance dependence, or psychosis. Participants were excluded if they met diagnostic criteria for a major depressive episode, manic episode, or substance dependence during the two weeks prior to enrolling in the study, or if they met criteria for a primary psychotic disorder in their lifetime. Diagnoses were assessed using the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID; First et al.,

1996), with "good" to "substantial" agreement (Landis & Koch, 1977) between assessors and the first author (average kappa = .62; absolute rates of rater agreement = 80-100%).

The present analyses focused on 25 participants (92% female; mean age = 23.12, *SD* = 3.81) who endorsed one or more episode of NSSI and one or more episode of DE (binge eating, purging, or fasting) during the diary period.[1] These participants identified as White (68%), Asian (12%) and South Asian (12%). Roughly half of the sample were students (52%), while the remaining participants were working full- (16%) or part-time (16%), or were unemployed (16%).

2.2 Procedures

Procedures for this study are described in detail in Turner et al. (2016). Briefly, after completing baseline self-report measures during a laboratory session, participants logged in to a secure, online portal each evening to complete diaries for fourteen days. Within each entry, participants rated their mood during three designated periods: the morning (defined as waking until noon), afternoon (defined as noon until 6 p.m.) and evening (defined as 6 p.m. until diary completion). This method provides relatively complete coverage of daily experiences and facilitated the examination of mood intensity and variability on days with and without NSSI and

[1] Given that the analyses focused on a subset of the full sample recruited for this study, we compared participants who met inclusion and exclusion criteria for the NSSI group to the subset included in the present analyses. Compared to the full sample, participants in the subsample did not differ with respect to lifetime frequency of NSSI ($t(58) = -1.21$, $p = 0.23$), number of current or lifetime psychiatric disorders ($ts(58) = -1.28$ to -1.67, $ps > 0.10$), presence of current mood, substance use or anxiety disorders (χ^2s = 0.26 to 0.73, $ps > 0.25$), or severity of borderline personality symptoms ($t(58) = -1.63$, $p = 0.11$), as assessed by the Personality Assessment Inventory (Morey, 1991). Moreover, there were no differences in endorsement of intrapersonal or interpersonal functions of NSSI between the subsample and full sample ($ts(55) = 0.63$ to 1.59, $ps > 0.10$). Participants in the subsample engaged in more versatile NSSI (i.e., used a greater number of methods; $t(58) = -2.43$, $p = 0.02$), endorsed more severe eating disorder symptoms ($t(58) = -2.70$, $p = 0.01$), and had more severe symptoms of depression, $t(58) = -2.95$, $p = 0.01$), but not stress or anxiety ($ts(58) = -0.98$ to -1.38, $ps > 0.10$), in the past week as assessed by the short form of the Depression, Anxiety and Stress scale (Lovibond & Lovibond, 1995).

DE behaviors. Advantages of this approach include a reduction in participant burden relative to ecological momentary assessment protocols, which was expected to increase compliance and reduce missing data (Kahneman et al., 2004). At the end of each diary entry, participants were asked whether they had engaged in NSSI, binge eating, purging, and fasting behaviors at any time that day. If NSSI or DE were endorsed, participants completed a standardized set of follow-up questions assessing the social and emotional context of each behavior (described in Table 2). Participants who completed at least 5 of the 7 entries on either week received $45, and those who completed all 7 entries received $60, for a maximum compensation of $120.

2.3 Baseline Symptom Measures

2.3.1 Eating disorder symptoms. The Eating Disorder Examination Questionnaire (EDE-Q 6.0; Fairburn and Beglin, 2008) is a 28-item self-report measure assessing eating disorder symptoms and behaviors in the past 28 days over the following domains: eating restraint, eating concerns, shape concerns, and weight concerns. Frequency of symptoms are rated on a 0 (‘*no days*’) to 6 (‘*every day*’) scale. Items are averaged to create scores for each subscale, and subscales are averaged to create a global score. Previous norms were used to identify a clinical cut-off indicating a global score at or above the 75th percentile (Mond et al., 2006), which has been shown to have adequate sensitivity (0.86) and specificity (0.92) in detecting the presence of an eating disorder (Mond et al., 2004). The internal consistency of the EDE-Q demonstrated in the present sample ranged from $\alpha = 0.75$ to 0.94 for the subscales and was $\alpha = 0.97$ for the total score.

2.3.2. NSSI. History of NSSI was assessed with the Deliberate Self-harm Inventory (Gratz, 2001), a 17-item questionnaire assessing the presence, frequency, severity, onset and recency of 17 different methods of NSSI. The Spearman-Brown coefficient of this measure was

low (0.58), likely due to the variability in endorsement of different methods of NSSI in this sample.

2.4 Daily Diary Measures

2.4.1 NSSI and ED behaviors. NSSI, binge eating, and purging were each assessed with a single item asking participants "Did you engage in [nonsuicidal self-injury/binge eating/purging] today?" NSSI was defined as "injuring yourself without intending to kill yourself." Binge eating was defined as "eating an objectively large amount of food in a manner that felt out of control." Purging was defined as "using vomiting, laxatives, diuretics or excessive exercise to compensate for what you had eaten." Fasting behaviors were assessed with two items: one asked participants if they had "skipped more than two meals to control [their] weight or shape", and the other asked if participants if participants had "gone eight waking hours without eating" (see Engel et al., 2013). Each behavior was scored as present (1) or absent (0) each day. For each behavior endorsed, participants responded to follow-up questions based on prior work (Kleindienst et al., 2008; Nock et al., 2009). In particular, we assessed activities, specific emotional states, duration of thoughts, social contexts, and functions using items based on work by Nock et al. (2009) and supplemented the list of preceding stressors using items from Kleindienst et al. (2008). Item wordings and response options are presented in Tables 2 and 3.

2.4.2 Daily mood. Participants rated their average mood during each of the morning, afternoon, and evening using the Multidimensional Mood Questionnaire (MDMQ; Wilhelm and Schoebi, 2007). The MDMQ uses six bipolar items to assess three diffuse aspects of mood: valence ("*content-discontent*", "*well-unwell*"), tense arousal ("*relaxed-tense*", "*agitated-calm*"), and energy/alertness ("*tired-awake*", "*full of energy-without energy*"). In contrast with two-dimensional models of mood (e.g., Russell, 2003; Watson and Tellegen, 1985; Yik et al., 1999),

the three-dimensional model distinguishes tension (i.e., relaxation versus agitation) from energetic arousal (i.e., alertness versus fatigue; Thayer, 1989), in addition to distinguishing moods by valence (see Matthews et al., 1990; Schimmack and Reisenzein, 2002). Each MDMQ scale was scored so that higher scores indicated greater negatively-valenced mood, agitation, and fatigue. Previous micro-longitudinal research supports the three-dimensional structure and reliability of this measure (Wilhelm and Schoebi, 2007). In the present study, the MDMQ subscales had marginal to adequate internal consistency (negative valence = 0.79; agitation = 0.77; fatigue = 0.62).

2.5 Data Analytic Plan

The first aim of this study was to describe the frequency and context of NSSI and DE behaviors as they occurred over a naturalistic monitoring period. To do so, we used cross-tabulations to describe frequencies of response options for each type of behavior. These analyses focused on the set of 133 NSSI and DE behaviors observed during this study. For checklist-style responses (i.e., where more than one response could be selected, and each response can be conceptualized as present or absent), we began by summing the number of activities, stressors, and specific emotions to create three total scores, and then used ANOVAs to test differences in the total according to behavior type. To examine whether specific activities, stressors, or emotions predicted likelihood of acting on NSSI or DE thoughts, we used multilevel level modeling (MLM). Each set of contextual variables was entered as fixed, level 1 predictors; given the small sample and the focus of the present study on within-person effects, level 2 covariates were not included. The dichotomous outcomes (NSSI or DE behaviors) were modelled via a Bernoulli distribution and logit link function to derive multilevel logistic regressions in HLM 7.01 software (Bryk et al., 2010). For categorical contextual variables (i.e., only one response

option could be selected from mutually exclusive categories; time interval from thought to action, social context of urges, and functions of the behavior), we used chi-squares to compare response frequencies by behavior type. We then used post-hoc pairwise comparisons to clarify differences, using a more conservative cut-off ($p < .01$) to reduce Type II error. Post-hoc power analyses revealed that power to detect a medium effect ranged from .68 to .88 for chi-square tests (given $\alpha = 0.05$ and $\omega = 0.30$), and was > 0.90 for large effects. Power calculations were not performed for MLM analyses, given methods for doing so are not well established.

The second aim was to compare intensity and variability of each aspect of mood (negative valence, agitation, and fatigue) on days where NSSI or DE had occurred, which was also accomplished using MLM. A first set of MLM models tested whether mean-level of mood (i.e., intensity) differed on days when NSSI versus binge eating/purging, or NSSI versus fasting, occurred. We used three-level models with piecewise modeling of time (i.e., dummy-coded coefficients for morning, afternoon, and evening). Using a piecewise model for time allowed us to examine mood intensity over the three periods without assuming that linear or non-linear course would equally apply across days with NSSI or DE. The second set of MLM models compared the within-person, within-day standard deviation of each aspect mood (i.e., mood variability) on days with NSSI versus binge eating or purging, and NSSI versus fasting. Because the index of mood variability collapses the three daily mood ratings into a single index of variability, two-level models were used for these analyses. Further detail regarding these multilevel models is available from the first author.

3. Results

3.1 Sample Characteristics

Baseline NSSI and eating disorder symptoms in the current sample are summarized in Table 1. Nearly all of the participants had a history of psychiatric treatment (96%). Underscoring the clinical severity of this sample, 64% met the EDE-Q cut-off score indicating symptom severity at or above the 75th percentile, which indicates the probable presence of an eating disorder. Within the past 28 days, 48% of participants had engaged in fasting, 56% had engaged in binge-eating, 23% had engaged in self-induced vomiting and 40% had engaged in over-exercising as a means of controlling their shape or weight. The mean Body Mass Index (BMI) within this sample was 24.89 (*SD* = 6.19). Applying BMI cut-offs, 12% of participants were classified as underweight, 48% were normal weight, 16% were overweight and 24% were obese.

With respect to NSSI characteristics, the median number of lifetime NSSI acts was 307, and the median number of NSSI methods used was seven. Most participants endorsed a history of engaging in severe forms of NSSI, such as cutting (88%) and burning (48%). Roughly one quarter (24%) had received medical attention as a result of their NSSI.

3.2 Diary Compliance

Participants completed a total of 318 valid diary entries, with an average of 12.72 entries per person (*SD* = 2.11, range = 7 to 15). Rates of diary compliance were not related to age ($r(25) = 0.11$, $p = 0.59$), gender ($t(23) = 0.15$, $p = 0.88$), baseline NSSI frequency ($r(25) = 0.08$, $p = 0.69$) or baseline eating disorder symptom severity ($r(25) = 0.05$, $p = 0.80$). MLM analyses therefore utilized 954 occasion-level observations (e.g., mood ratings during the three daily periods) and 318 day-level observations (e.g., reports on presence/absence of NSSI or DE each day).

3.3 Describing NSSI and ED behaviors

Diary entries described 51 episodes of NSSI (mean NSSI days per person = 2.08, *SD* = 1.44), 39 episodes of binge eating or purging behaviors (mean binge eating/purging days per person = 1.44, *SD* = 1.56), and 43 episodes of fasting (mean days per person = 1.72, *SD* = 2.54). NSSI and DE co-occurred on a total of 16 days (5% of total valid entries): on 7 days, participants engaged in both NSSI and binge eating or purging behavior, on 8 days participants engaged in both NSSI and fasting, and on one day a participant engaged in all three behaviors.

Table 2 describes the activities, stressors, and specific emotions that preceded thoughts of NSSI and DE. Participants reported they were most often resting, working or doing schoolwork, or watching television when thoughts of NSSI or DE began. The most common stressors to precede NSSI or DE thoughts included arguments or conflict with others, being isolated or alone, and someone being disappointed. Emotions that were frequently reported to precede NSSI and DE included feeling overwhelmed, self-hatred, and sad or worthless. The number of activities reported to precede NSSI and DE did not differ by behavior type ($F_{2,114)} = 0.57$, $p = 0.57$, $\eta^2 = 0.01$). There was a significant difference in the number of stressors that preceded thoughts about each behavior ($F_{(2,120)} = 9.33$, $p < 0.001$, $\eta^2 = 0.14$); post-hoc comparisons revealed that more stressors preceded NSSI versus fasting thoughts (mean difference = 1.68, S.E. = 0.39, $p < 0.001$). There was a significant difference in the number of reported negative emotions that preceded each behavior ($F_{(2,111)} = 4.72$, $p = 0.01$, $\eta^2 = 0.08$); post-hoc comparisons revealed that participants endorsed more specific negative emotions prior to NSSI compared to fasting (mean difference = 1.15, S.E. = 0.43, $p = 0.02$) or binge eating or purging behavior (mean difference = 0.89, S.E. = 0.37, $p = 0.048$).

In terms of specific precipitants that predicted likelihood of acting on NSSI or DE thoughts, consistent with Hypothesis 1, participants were significantly more likely to act on their

binge eating or purging thoughts if the thoughts began when they were eating ($\gamma = 1.53$, SE = 0.41, $t(75) = 3.74$, $p < 0.001$) or watching television ($\gamma = 1.14$, SE = 0.40, $t(75) = 2.84$, $p = 0.006$). None of the specific activities predicted greater likelihood of acting on NSSI or fasting thoughts. With respect to precipitating stressors, participants were significantly more likely to act on NSSI thoughts when the thought had been preceded by arguments or conflicts with others ($\gamma = 2.23$, SE = 0.66, $t(72) = 3.36$, $p = 0.001$), and were less likely to act on NSSI thoughts when they had been preceded by financial problems ($\gamma = -1.65$, SE = 0.58, $t(72) = -2.83$, $p = 0.006$). In contrast, participants were more likely to act on fasting thoughts when the thought was preceded by talking about upsetting memories ($\gamma = 1.11$, SE = 0.47, $t(72) = 2.37$, $p = 0.02$), whereas they were less likely to act on fasting thoughts when the thought was preceded by being unable to spend time with someone ($\gamma = -2.27$, SE = 0.68, $t(72) = -3.33$, $p = 0.001$). None of the stressors predicted likelihood of acting on binge eating or purging thoughts. Finally, with respect to specific emotional precipitants, participants were significantly more likely to act on NSSI thoughts when they felt rejected or hurt immediately before ($\gamma = 1.59$, SE = 0.67, $t(76) = 2.38$, $p = 0.02$), whereas they were more likely to act on binge eating or purging thoughts when these thoughts were preceded by feeling self-hatred ($\gamma = 1.69$, SE = 0.62, $t(77) = 2.72$, $p = 0.008$). None of the specific emotional precipitants predicted likelihood of acting on fasting thoughts.

Table 3 describes the duration of the transition from NSSI or DE thoughts to actions, the social contexts of NSSI or DE urges, and the functions of NSSI or DE behaviors.. There were no significant differences in the time elapsed from thought onset to onset of behavior ($F_{(2,109)} = 0.53$, $p = 0.59$, $\eta^2 = 0.01$), with this transition to action taking on average 1 to 30 minutes in both NSSI and DE. Although there was an overall difference in the social context of urges, none of the post-hoc comparisons reached the more conservative $p < 0.01$ cut-off. Using a more lenient cut-off of

$p < 0.05$, results suggested that fasting thoughts more often began when participants were in a public setting ($\chi^2_{(2)} = 8.86$, $p = 0.01$, $\phi = .29$), compared to NSSI or binging or purging thoughts, whereas binge eating or purging thoughts more often began when participants were with family ($\chi^2_{(2)} = 7.58$, $p = 0.02$, $\phi = .26$). The proportion of NSSI, binge eating/purging and fasting acts that were reported to serve each function did not significantly differ ($\chi^2_{(6)} = 9.86$, $p = 0.13$). The most frequently endorsed function across behaviors was "to get rid of thoughts and feelings", followed by "to escape a task or other people".

3.4 Mean-level and Variability of Mood on Days with NSSI or DE

Mood intensity within each of the three periods on days with NSSI, binge eating or purging, fasting, and no NSSI/DE are depicted in Figure 1. Multilevel models revealed significant differences in the intensity of mood in the evenings of days with NSSI versus fasting (see Table 4). Specifically, relative to days with NSSI, fasting was associated with significantly less intense negative mood ($\gamma_{320} = -0.65$, $SE = 0.18$, $t_{(137)} = -3.57$, $p < 0.001$), less agitation ($\gamma_{320} = -0.41$, $SE = 0.21$, $t_{(137)} = -1.99$, $p = 0.049$), and less fatigue ($\gamma_{320} = -0.35$, $SE = 0.17$, $t_{(137)} = -2.06$, $p = 0.041$) in the evening. Relative to days with binge eating or purging, days with NSSI were associated with more intense fatigue in the morning ($\gamma_{110} = 0.47$, $SE = 0.20$, $t_{(82)} = -2.32$, $p = 0.023$).

In terms of mood variability, multilevel models revealed a significant difference in variability of negatively valenced mood on days with NSSI versus binge eating or purging ($\gamma_{10} = -0.20$, $SE = 0.06$, $t_{(24)} = -3.14$, $p = 0.004$, see Table 4). There were no significant differences between NSSI versus DE days in variability of agitation or fatigue (ps > 0.10).

4. Discussion

Whereas high rates of co-occurrence between NSSI and DE have been documented for decades (Claes et al., 2001; Favaro and Santonastaso, 1999; Favazza and Conterio, 1989), little is known regarding within-person processes that predict which behavior will be emitted, when, and how the social and emotional contexts of these behaviors differ. By directly comparing NSSI and DE occurring within a single population using a naturalistic daily diary design, the current study takes a first step toward addressing this important gap in the literature (Claes and Muehlenkamp, 2014). Although our results should be considered preliminary due to the small sample size, the use of a single daily report, and the inability to directly examine emotion regulatory functions of these behaviors, we believe this study nonetheless makes several significant contributions that can direct future research in this area. Our results corroborate previous micro-longitudinal studies that have shown that weekly co-occurrence of NSSI and DE may be quite common. Even when study samples are recruited based on their engagement in one of these behaviors, secondary analyses show that roughly 15 to 40% of participants have engaged in other self-damaging behaviors during the monitoring periods (Anestis et al., 2012; Muehlenkamp et al., 2009; Shingleton et al., 2013). In the current study, 25 of the 60 participants (42%) who were selected for their engagement in NSSI reported some DE behavior during the two-week diary period. Moreover, there were few differences between the subsample who engaged in both NSSI and DE during the diary period and participants in the full NSSI sample. Among participants who had engaged in both behaviors during the two-week diary period, results showed that NSSI and DE co-occurred on roughly one third of the days when either behavior was present. It is important, therefore, that researchers who are seeking to understand the emotional and social contexts of self-damaging behaviors assess a broad scope in order to capture the range of behaviors that an individual may be using to modify his or her emotional experience. In

particular, these findings raise concerns about studies that have examined emotion regulatory functions of one behavior (e.g., NSSI) without examining other behaviors (e.g., DE) that a person may be using to serve similar functions.

The current study takes steps toward answering another crucial question in the literature: given that both NSSI and DE appear to be functionally equivalent in regulating negative emotions, are these behaviors used interchangeably or are there certain contexts in which one behavior is preferred? Consistent literature that underscores the role of negative reinforcement in the maintenance of both NSSI and DE, we found that the majority of these behaviors were described as serving to "get rid of thoughts and feelings" or "escape a task or other people". Constraints related to the frequency of daily assessments limited our ability to directly examine changes in mood following these behaviors in this study, and this remains an important direction for future research. Given existing research demonstrating that negative affect typically decreases or stabilizes following NSSI and DE (Armey et al., 2011; Engel et al., 2013; Haines et al., 1995), as well as the theory emphasizing the emotion regulatory effect of these behaviors (see Claes and Muehlenkamp, 2014), it may be reasonable to suspect that worse mood occurred leading up to these behaviors rather than following it. Thus, with this assumption in mind, comparisons of mood trajectories on days with NSSI versus DE in this study suggest that NSSI may occur on days where mood becomes increasingly negative and agitated throughout the day. This suggests that interventions targeting emotion regulation skills or aspects of mood more broadly (e.g., behavioral activation) may be uniquely helpful in diminishing NSSI. Even if mood worsened after, rather than before, NSSI behavior occurred, helping patients to regulate worsening moods throughout the day remains an important clinical target in this population.

In addition, our results provide suggestions on ways that a functional equivalence model can be refined to include contextual cues to understand circumstances that are most likely to elicit preference for one behavior over the other. For instance, NSSI was associated with a greater number of specific negative emotions (i.e., rejection) and a greater number of interpersonal stressors (i.e., conflict and arguments), compared to fasting. Moreover, multilevel models revealed that NSSI is associated with worse mood, particularly in the afternoon and evening, compared to days on which fasting and binge eating or purging occurred. This suggests that NSSI may be more likely to occur in response to acute emotional and social events, particularly when multiple stressors and negative emotions converge. Binge eating or purging were uniquely associated with contexts and activities that might increase exposure to food- and weight-related cues (e.g., eating, watching television or movies, being with family), and with feelings of self-hatred. Fasting behavior, on the other hand, was usually considered when participants were in public settings; it may be that participants were more likely to consider fasting when presented with opportunities to engage in social comparisons (Leahey et al., 2011), particularly to peers (Ferguson et al., 2011). Thus, despite participants' self-reports that all three behaviors served primarily to regulate distress (i.e., "to get rid of thoughts and feelings"), micro-longitudinal results show these behaviors could be understood as arising from a combination of general negative affect and specific environmental cues that are associated with each particular behavior.

Several study limitations warrant consideration. First, as acknowledged above, because the population of interest was only those participants who engaged in *both* NSSI and DE during the diary period, our sample size for the current analyses was small, limiting our ability to examine between-person effects. Although this sample size is similar to some previous micro-

longitudinal studies of NSSI and DE, which have relied on samples of 27 to 36 participants (Armey et al., 2011; Nock et al., 2009; Shingleton et al., 2013; Wegner et al., 2002), replication in larger and more diverse samples is needed. A second limitation arose because NSSI and DE were assessed only once per day and irrespective of time at which the behavior occurred. Due to this constraint, we were unable to compare trajectories of mood before and after the occurrence of NSSI or DE, limiting our ability to directly test the proposed emotion regulatory functions. Use of more frequent sampling schedules in future studies will be essential for directly testing hypotheses regarding different emotional contexts that uniquely relate to NSSI versus DE. Past studies examining negative affect in relation to NSSI or DE have found quadratic (Armey et al., 2011; Engel et al., 2013) and cubic trends (Engel et al., 2013), suggesting that negative emotions rapidly increase leading up to the behavior, followed by stabilization or decline in these emotions. To capture these rapid changes, particularly for specific emotions, optimal sampling frequency may require at least six assessments per day. Furthermore, the use of event-contingent reporting, which allows participants to create a new report whenever a predefined behavior or event occurs, can help to locate the time of behavior more precisely (e.g., Armey et al., 2011), enhancing the ability to examine the antecedents and consequences of a behavior and reducing potential recall biases. Thus, although the present use of a daily diary design improves upon the largely retrospective and aggregated nature of previous comparisons of NSSI and DE behaviors, limitations remain that will optimally be addressed via additional micro-longitudinal research. A final limitation resulted from recruitment and inclusion criteria that focused exclusively on NSSI behaviors, as well as the use of community sample. It is important to examine the characteristics of NSSI and DE in clinical samples, particularly with DE that is likely to or has come to clinical

attention, as the social and emotional contexts of these behaviors may differ in those with more severe DE.

Despite these limitations, this study is unique in its description and comparison of factors related to NSSI and DE in a single sample using micro-longitudinal methods. As such, our findings build on a growing literature that shows high rates of within- and between-person co-occurrence of DE and NSSI, and suggest several ways in which NSSI and DE may differ from one another, despite their similar functions. Our findings, while preliminary, can guide future micro-longitudinal studies regarding potential emotional or cognitive states are associated with the selection of one behavior versus the other (e.g., rejection may be more strongly associated with NSSI, whereas social comparisons and self-critical emotions may be associated with DE). These findings will hopefully stimulate additional research regarding when and how particular behaviors co-occur. By integrating knowledge of state and trait processes that increase an individual's risk for engaging in self-damaging behaviors, we can design more effective and efficient interventions to reduce these behaviors.

Acknowledgements

The authors wish to gratefully acknowledge the Canadian Institutes of Health Research Frederick Banting and Charles Best Canada Graduate Scholarship to the first author and Operating Grant to the last author, which supported this research.

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Table 1. NSSI and ED symptoms in current sample.

	Minimum	Maximum	Mean	SD
NSSI frequency	61.00	1642.00	526.38	478.74
NSSI methods	2.00	10.00	7.00	2.04
EDE-Q Global score	0	5.86	3.07	1.70
EDE-Q Eating restraint	0	6.00	2.44	1.86
EDE-Q Eating concern	0	4.60	1.96	1.53
EDE-Q Weight concern	0	6.86	4.21	2.12
EDE-Q Shape concern	0	6.00	3.23	1.78

Table 2. Activities, stressors, and emotions that precede NSSI versus DE behaviors.

	NSSI *n* = 51		Binge/ Purge *n* = 39		Fasting *n* = 27	
	%	95% OR for acting on thoughts	%	95% OR for acting on thoughts	%	95% OR for acting on thoughts
What were you doing when you started thinking about this behavior?*						
Listening to music	21.6	0.45 to 4.02	12.8	0.39 to 2.51	25.9	0.26 to 3.68
Eating	23.5	0.53 to 2.78	**53.8**	**2.05 to 10.48**	3.7	0.15 to 1.38
Resting	47.1	0.59 to 4.01	25.6	0.29 to 1.59	40.7	0.41 to 2.17
Watching TV or a movie	25.5	0.53 to 2.97	**41.0**	**1.40 to 6.92**	11.1	0.39 to 1.94
Socializing	27.5	0.40 to 2.58	23.1	0.23 to 1.25	29.6	0.55 to 3.18
Working, doing schoolwork or homework	35.3	0.33 to 1.62	30.8	0.83 to 3.60	51.9	0.57 to 1.69
Recreational activity	17.6	0.23 to 1.69	10.3	0.45 to 3.04	7.4	0.24 to 2.92
Using drugs	2.0	0.05 to 1.91	7.7	0.35 to 6.75	0.0	--*
Drinking alcohol	2.0	--*	2.6	--*	0.0	--*
Did any of the following events happen right before the thoughts started?*						
You had an argument or conflict with another person	**35.3**	**2.48 to 35.09**	23.1	0.07 to 2.23	7.4	0.33 to 5.07
You tried to spend time with someone but couldn't	15.7	0.56 to 4.37	10.3	0.54 to 7.11	**0.0**	**0.03 to 0.40**
Someone was disappointed with you	23.5	0.10 to 2.17	20.5	0.52 to 10.70	0.0	0.15 to 2.11
Someone was angry with you, criticized or put you down	19.6	0.04 to 2.95	12.8	0.14 to 12.20	3.7	0.78 to 4.19
Someone let you down or broke a promise	21.6	0.84 to 5.53	15.4	0.26 to 2.14	3.7	0.58 to 2.36
Someone rejected you	21.6	0.30 to 2.04	12.8	0.47 to 13.05	0.0	0.33 to 3.11
You lost someone important (even if it was temporary)	13.7	0.55 to 29.62	5.1	0.32 to 7.94	3.7	0.24 to 4.43
You were isolated or more alone than you wanted to be	27.5	0.33 to 2.78	28.2	0.17 to 2.84	18.5	0.43 to 1.88
You had financial problems	**9.8**	**0.06 to 0.62**	12.8	0.80 to 5.79	7.4	0.54 to 2.94
You had health problems or physical discomfort	9.8	0.44 to 3.02	15.4	0.79 to 6.06	3.7	0.30 to 2.52
You had a new demand	13.7	0.62 to 3.49	15.4	0.82 to 9.32	11.1	0.15 to 1.99

You talked about upsetting memories or events	13.7	0.16 to 2.42	5.1	0.82 to 7.60	**11.1**	**1.19 to 7.79**
What were you feeling right before?*						
Scared/anxious	39.2	0.55 to 4.02	25.6	0.43 to 3.70	8.3	0.22 to 1.49
Numb/nothing	21.6	0.75 to 4.17	25.6	0.40 to 3.79	45.8	0.56 to 2.76
Sad/worthless	49.0	0.49 to 5.64	41.0	0.30 to 2.61	37.5	0.43 to 3.11
Angry at self	41.2	0.26 to 8.89	23.1	0.18 to 2.26	29.2	0.37 to 2.58
Self-hatred	39.2	0.19 to 1.35	**43.6**	**1.57 to 18.75**	45.8	0.33 to 2.48
Angry at others	25.5	0.22 to 1.86	12.8	0.44 to 4.39	12.5	0.62 to 5.39
Rejected/hurt	**45.1**	**1.29 to 18.42**	15.4	0.24 to 2.54	12.5	0.22 to 1.38
Overwhelmed	58.8	0.85 to 6.79	43.6	0.55 to 2.82	12.5	0.26 to 1.39

Significant coefficients in each MLM model ($p < .05$) are shown in bold text.

Note. Because follow-up questions regarding fasting behavior were only asked if participants endorsed skipping more than two meals to control [their] weight or shape, resulting in missing data for episodes of fasting that had instead been characterized by going eight or more waking hours without eating. * Models that included drinking alcohol or using drugs as level 1 predictors did not converge, likely due to perfect overlap with other predictors in the model. These precipitating activities were therefore removed from the MLM models.

Table 3. Duration and social context of urges, and functions of NSSI versus DE behaviors.

	NSSI	Binge/ Purge	Fasting			
	n = 51	*n* = 39	*n* = 27	$\chi 2$ / F	*p*	ϕ / $\eta 2$
How long did you think this behavior about before acting?				**F = 0.54**	**0.59**	**$\eta 2$ = 0.01**
Less than 5 seconds	32.0	12.8	21.7		0.10	
5 seconds to 1 minute	6.0	28.2	17.4		0.02	
1 to 30 minutes	26.0	38.5	21.7		0.29	
30 minutes to 1 hour	12.0	7.7	13.0		0.75	
1 to 5 hours	16.0	12.8	8.7		0.69	
More than 5 hours	8.0	0.0	17.4		0.04	
When the strongest urge began were you?				**$\chi 2$ = 17.80**	**0.02**	**ϕ = 0.40**
Alone	75.0	63.9	68.0		0.54	
With friends	4.2	8.3	0.0		0.31	
With family	6.3	19.4	0.0		0.02	
At work or school	8.3	5.6	8.0		0.88	
In another public setting	6.3	2.8	24.0		0.01	
Why did you engage in this behavior?				**$\chi 2$ = 9.86**	**0.13**	**ϕ = 0.30**
To communicate something	2.0	0.0	0.0		0.53	
To get rid of thoughts and feelings	67.3	81.6	54.2		0.07	
To feel something	14.3	7.9	8.3		0.58	
To escape a task or other people	16.3	10.5	37.5		0.03	

Note. Because follow-up questions regarding fasting behavior were only asked if participants endorsed skipping more than two meals to control [their] weight or shape, resulting in missing data for episodes of fasting that had instead been characterized by going eight or more waking hours without eating.

Table 4. Level and variability of mood on days on which NSSI or disordered eating occurred.

	MLM predicting average negative mood					
	Morning		Afternoon		Evening	
	γ	SE	γ	SE	γ	SE
NSSI	2.394	0.257	2.744	0.27	3.055	0.297
Binge eating or purging	2.102	0.35	2.096	0.305	2.438	0.359
Fasting	2.569	0.272	2.486	0.331	2.54	0.356
	MLM predicting average agitated mood					
	Morning		Afternoon		Evening	
	γ	SE	γ	SE	γ	SE
NSSI	2.503	0.229	3.034	0.277	3.145	0.307
Binge eating or purging	2.298	0.222	2.316	0.337	2.463	0.334
Fasting	2.809	0.151	2.968	0.209	2.739	0.256
	MLM predicting average fatigued mood					
	Morning		Afternoon		Evening	
	γ	SE	γ	SE	γ	SE
NSSI	3.003	0.323	2.743	0.303	3.291	0.259
Binge eating or purging	2.567	0.381	1.985	0.293	2.685	0.426
Fasting	3.23	0.342	2.528	0.27	2.71	0.487
	MLM predicting negative mood variability					
	γ		SE			
NSSI	0.678		0.09			
Binge eating or purging	0.762		0.177			
Fasting	0.504		0.099			
	MLM predicting agitated mood variability					
	γ		SE			
NSSI	0.864		0.113			
Binge eating or purging	0.715		0.171			
Fasting	0.669		0.124			
	MLM predicting fatigued mood variability					
	γ		SE			
NSSI	0.91		0.156			
Binge eating or purging	0.994		0.198			
Fasting	0.786		0.148			

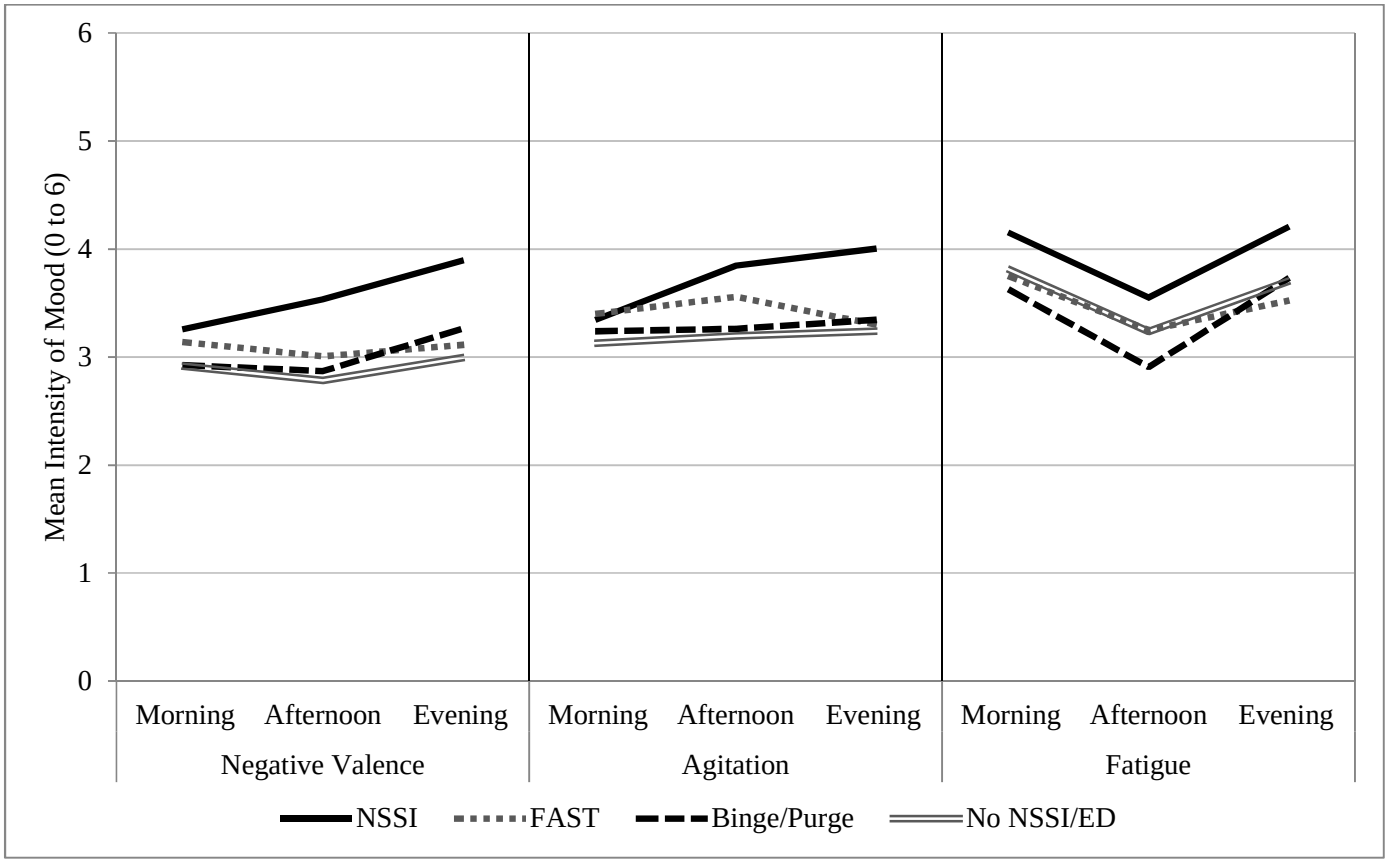

Figure 1. Trajectories of negatively valenced mood, agitation, and fatigue on days on which NSSI, disordered eating, or neither behavior occurred.